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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/965,373	09/26/2001	Hua Chung	APPM/6303.02/CPI/COPPER/P	6509

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APPLIED MATERIALS, INC.
2881 SCOTT BLVD. M/S 2061
SANTA CLARA, CA 95050

EXAMINER	
LOUIE, WAI SING	

ART UNIT	PAPER NUMBER
2814	

DATE MAILED: 04/14/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/965,373	CHUNG ET AL.	
	Examiner	Art Unit	
	Wai-Sing Louie	2814	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 December 2003*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *7,11,12,14,19,20,22,27,28,31,34,37 and 39-57* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *7,11,12,14,19,20,22,27,28,31,34,37,39,40,42-46,48-50 and 52-56* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 41, 47, 51, and 57, are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

- In claims 41, 47, 51, and 57, "PDMAT" is new matter.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 7, 11-12, 14, 19-20, 22, 27-28, 31, 34, 37, 39-40, 42-46, 48-50, and 52-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cohen (US 6,610,151) in view of Kang et al. (US 6,139,700) and Wang et al. (US 6,387,806).

With regard to claims 7, 39, 44-45, and 52-54, Cohen discloses an apparatus for forming a seed layers for interconnects of a semiconductor device (col. 5, line 30 to col. 14, line 25 and fig. 7) comprising:

- Cohen discloses a chamber 76 for depositing a barrier layer 18 in via 16 (col. 6, lines 1-19 and fig. 1), where the barrier layer is made of TaN (col. 7, line 1), but does not disclose the barrier layer 18 is deposited by atomic layer deposition. However, Cohen discloses the apparatus is flexible enough and able to switch to ion plating, ionized metal plasma deposition, or atom deposition and controlling the deposition rate (col. 12, line 61 to col. 13, line 14). Kang et al. disclose the atomic layer deposition (ALD) is similar to CVD with the exception of reaction gases are introduced into the chamber (Kang col. 1, lines 54-62). Kang et al. teach the ALD has an excellent surface coverage, i.e., 100% (Kang col. 2, line 3). Therefore, it would have been obvious at the time the invention was made to modify Cohen's device with the teaching of Kang et al. to switch the barrier deposition chamber 76 to ALD chamber in order to have an excellent coverage in the via 16.
- A chamber 77 for physical vapor deposition a copper (Cu) alloy seed layer 20 over the barrier layer 18, but do not disclose the alloy concentration is between 0.01 to 2.0 atomic percent. However, Wang et al. disclose the Cu alloy contains 0.01 to 1 atomic percent of alloy elements (Wang col. 7, line 2). Wang et al. teach the 0.01 to 1.0 atomic percent is the solid solubility of metal dopant in Cu (Wang col. 7, lines 1-4). Thus, it would have been obvious for the one with ordinary skill

in the art to modify Kang's device with the teaching of Wang et al. to provide 0.01 to 1 atomic percent of metal dopant in Cu layer it is because 0.01 to 1 atomic percent is the suitable solid solubility of element in Cu. Wang et al. disclose zirconium is one of the element in the Cu alloy (Wang col. 6, line 61).

With regard to claim 11, Cohen discloses the Cu alloy seed layer 20 could be deposited by chemical vapor deposition (CVD) or physical vapor deposition (PVD) in chamber 77 (col. 10, lines 41-48). Cohen discloses the PVD chamber comprises an ionized metal plasma deposition (col. 12, line 61 to col. 13, line 14), which is the high-density plasma.

With regard to claims 12, 20, and 28, Cohen disclose a transfer chamber 73 for transferring a substrate 10 between the barrier chamber 76 and PVD Cu seed chamber 77 (col. 11, line 65 to col. 12, 3 and fig. 7).

With regard to claims 14, 22, 42-43, 48-49, and 55-56, in addition to the limitations disclosed in claim 7, Cohen also discloses:

- A non-conformal (undoped) Cu seed layer 22 in deposition chamber 78 (col. 12, lines 5-6 and fig. 7). The conformal Cu seed layer 20 is deposited by physical vapor deposition (PVD) in chamber 77 (col. 10, lines 41-48);
- The metal seed layer comprises copper and alloy of less noble metals (col. 1, lines 61-67). However, Wang et al. disclose the metallization includes copper (Wang col. 1, line 35), aluminum (Wang col. 1, line 24), zirconium (Wang col. 4, line 29). Therefore, it would have been obvious for the one with ordinary skill in the art to include aluminum and zirconium other than copper in Cohen's device.

With regard to claims 19 and 27, Cohen discloses the Cu alloy seed chamber 77 is an ionized metal plasma (high density plasma) PVD chamber and the non-conformal (undoped) Cu seed chamber 78 is a CVD chamber. Since the chambers are adoptable to switch the deposition process (col. 10, lines 41-48), the Cu layers deposition could be done in either deposition process.

With regard to claims 31, 34, and 37, Cohen discloses the Cu alloy seed layer 20 is deposited directly on the TaN barrier 18 (fig. 1).

With regard to claims 40, 46, 50, Cohen modified by Kang et al. in claim 7 above would disclose the barrier layer 18 deposited by ALD comprises the source gases including tantalum and nitrogen compound (Cohen col. 6, lines 3-19).

Response to Arguments

Applicant's arguments filed 12/11/03 have been fully considered:

- Applicant argues that there is no ground to combine Cohen with Kang et al. to switch the CVD with ALD to deposit the barrier layer (page 8). However, Kang et al. disclose the atomic layer deposition (ALD) is similar to CVD (Kang col. 1, lines 54-62) and Kang et al. teach the ALD has an excellent surface coverage (Kang col. 2, line 3), which is the motivation to combine. The combination of Cohen and Kang et al. is proper.
- Applicant argues that Cohen and Wang et al. do not teach or suggest a copper alloy seed layer comprising aluminum, magnesium, titanium, zirconium, tin or

combinations. Cohen discloses the seed chamber comprising copper, silver, and alloys of less noble metals (col. 1, lines 61-67) and Wang et al. disclose the metal seed deposition chamber could feed other metals such as aluminum and zirconium. Therefore, Cohen combine with Wang et al. could produce a copper-aluminum or copper-zirconium alloy seed layer.

- Applicant argues that there is no mention in Kang et al. of the deposition of TaN. However, Cohen discloses a TaN barrier layer 18 (col. 7, line 1).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wai-Sing Louie whose telephone number is (571) 272-1709. The examiner can normally be reached on 7:30 AM to 4:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

WSL
April 7, 2004.

LONG PHAM
PRIMARY EXAMINER